

Forces and Movement: Balanced and Unbalanced Forces

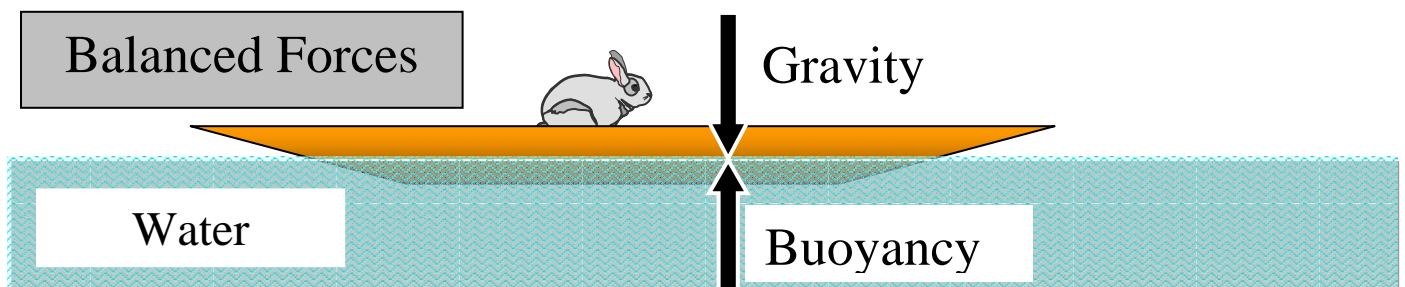
Forces are all around us. Without forces, nothing can move and no work can be done.

There are different types of forces. Some forces pull, some push, some twist, and so on.

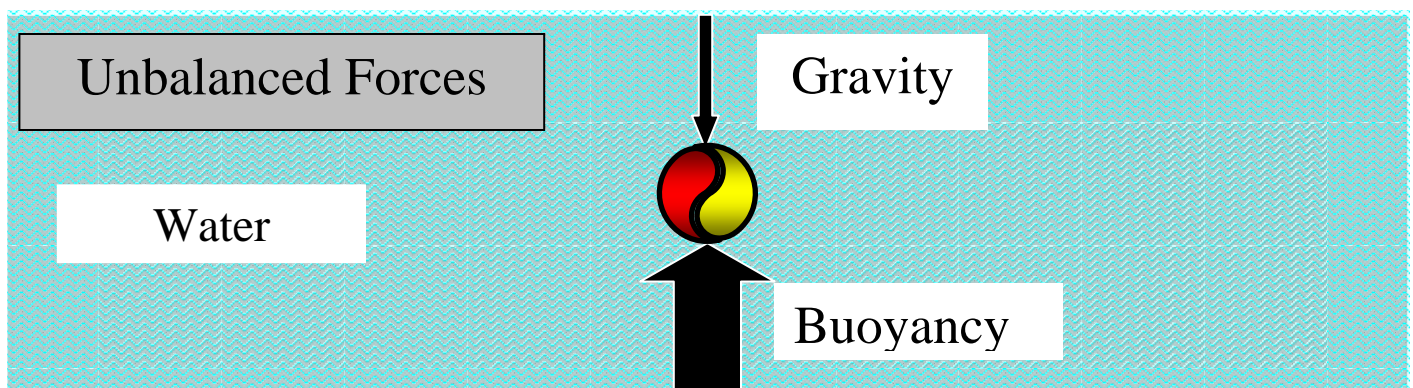
Gravity is a force that is always pulling us down. This downward direction never changes. All planets, moons, and stars pull objects towards them. Without Earth's gravity, we, along with everything else, would float into space!

Buoyancy is a pushing force. When you put anything in water, a force called buoyancy pushes it up. Buoyancy works in the opposite direction from gravity. For things to float in water, the forces of gravity and buoyancy must be equal.

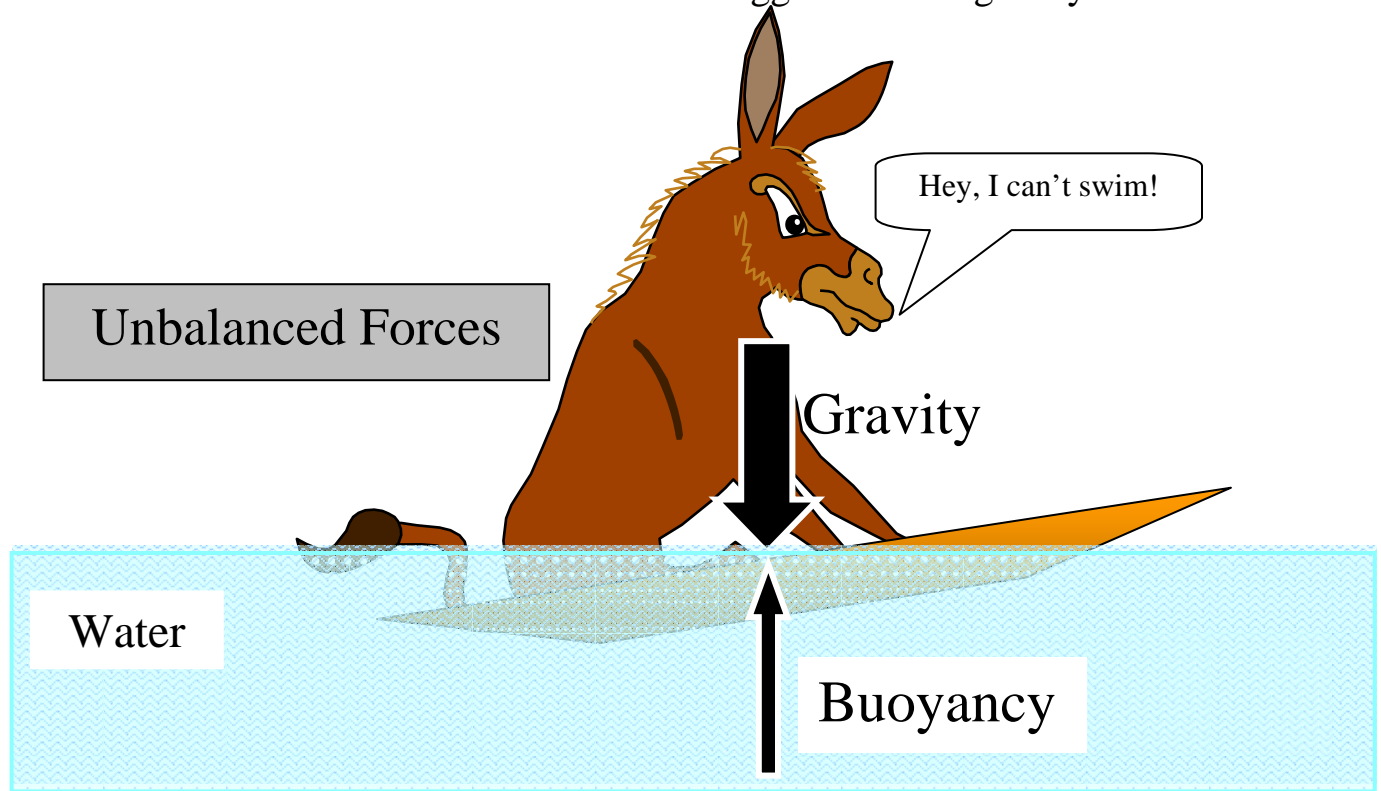
In this example, the forces of gravity and buoyancy are equal, but act in opposite directions. They cancel each other out. The boat and the rabbit will float. These are balanced forces, which cause no movement.



You can force a beach ball to the bottom of a pool but as soon as you let it go, it will be forced up and right out of water! Without your hand forcing the ball down, the upward push of buoyancy is greater than the downward pull of gravity. We say these forces are unbalanced.



A heavy load like this donkey can make a small boat sink. In this example, the pull of gravity is bigger than the push of buoyancy. The forces are unbalanced and both the boat and its load move down in the direction of the bigger force — gravity.



Energy, Forces and Movement

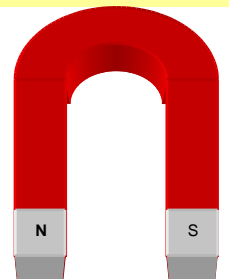
Without energy there can be no forces, and without forces nothing can move. We get our energy from the food we eat. Plants get their energy from the sun. Sailboats and windmills get their energy from the wind. A car gets its energy from the fuel it burns like gasoline. Electrical machines get their energy from electricity.

Magnetic Force

Magnets can attract or pull certain metals towards them. They can also push or pull other magnets. This is called magnetism or magnetic force. Opposite poles of magnets attract, while like poles always repel.

attract = pull towards

repel = push away

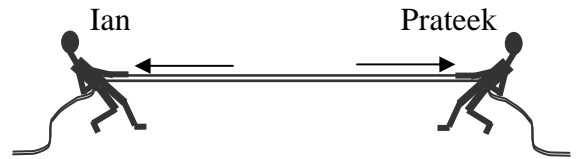


Muscular Force

People and animals use their muscles to move themselves or other objects. You need your muscles to lift weights, push or pull, walk, swim, talk, play, and even breathe. The heart is also made of muscles. It pumps the blood to every part of our body. Muscles give us muscular force.

Tug of War

Ian and Prateek are having a tug of war. They have the same mass and are pulling the rope with the same muscular force.

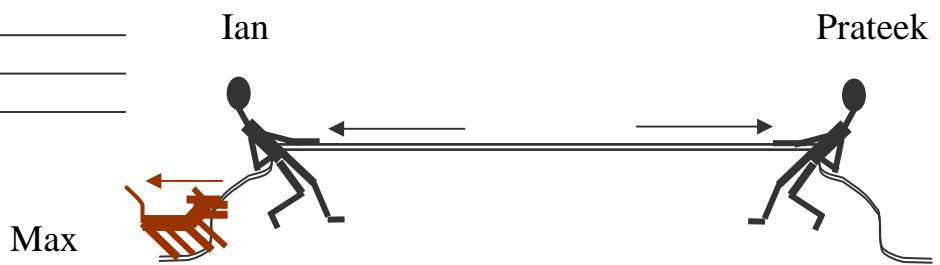


1. Are these forces balanced or unbalanced?

2. If they continue to pull with the same force, who is going to win?

3. What happens if Ian's puppy, Max, gently tugs the rope as in the picture?

4. Are the forces balanced now?

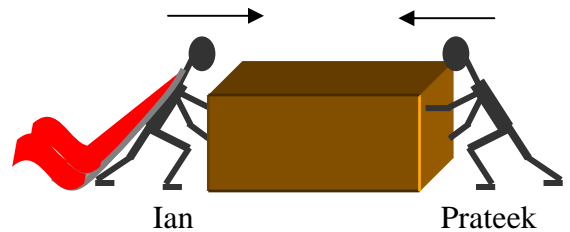


The Battle of Muscles Continues

Ian and his trusted sidekick, Max, were able to defeat Prateek in the last tug of war. This time Ian is wearing a cape to show his superhero strength. Both Prateek and Ian are pushing a box with the same force but from opposite sides.

5. Are these forces balanced or unbalanced?

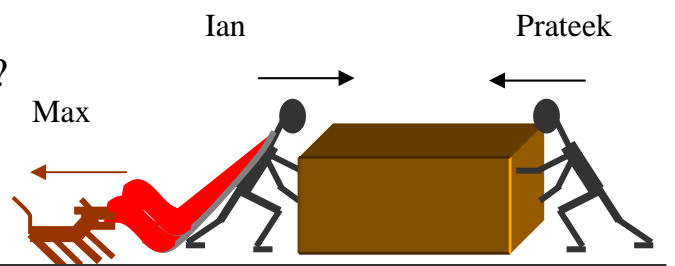
6. If they continue to push with the same force, who is going to win this match?



Finally, Max comes to the rescue and starts pulling his boss's cape.

7. Are the forces balanced now?

8. Who is going to win the match now? Why?



Friction

Friction is a force. When two surfaces rub against one another, a pushing force slows down their movements. Rough objects make more friction, because their surfaces “interlock” making it harder for them to move. The following pictures show three people trying to push an object over a surface. Label the arrows and answer the questions below.

1. Who has the toughest job? _____
2. Who has the easiest job? _____
3. Which surfaces create the most friction? _____
4. Which surfaces make the least friction? _____

Figure 1: Two rough surfaces are rubbing against each other.

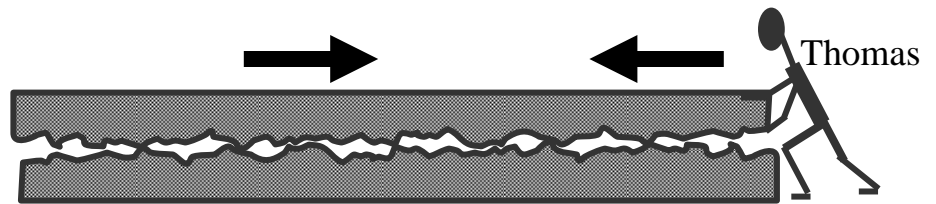


Figure 2: A smooth surface is rubbing against a rough surface.

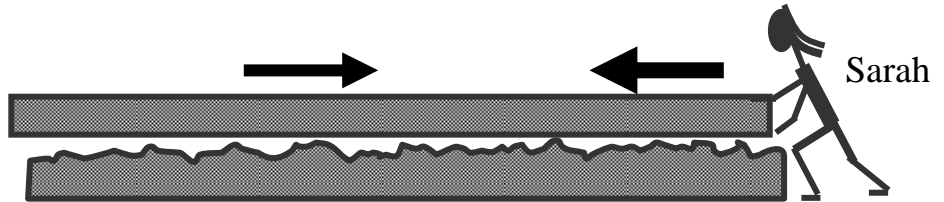


Figure 3: Two smooth surfaces are rubbing against each other.



Friction is a type of force that always acts in the opposite direction of movement. It slows down moving objects and makes them stop. Friction causes some of the energy of moving objects to turn into heat. That is why we rub our hands together on a cold winter day to make them warm.

What happens to the force of friction when objects stop moving? _____

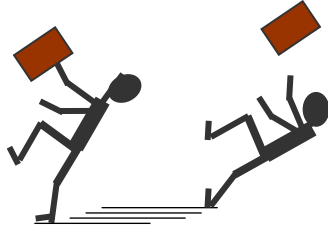
Decreasing Friction

Many times when we want things to move faster and more easily, we have to decrease friction. Mechanical parts of many machines are oiled regularly to help them move with as little friction as possible. Polishing, waxing, and oiling surfaces make them smoother and more slippery.

Increasing Friction

Sometimes we need more friction. When we want to stop or slow down a bike, we use the brakes. It is the friction between the brakes and the rim (a part of the wheel) that makes the bike and the rider slow down or stop.

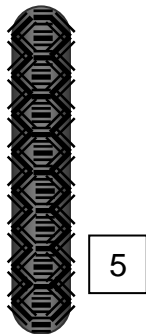
Without friction, we would not be able to walk, ride our bikes, or even drive our cars. We need enough friction to stop us from slipping on the ground.



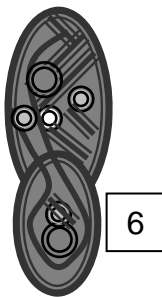
Not Enough Friction

Figure 4: Sliding on Slippery Ice

After a heavy snowfall some cars get stuck on the road or in their driveways. Even though their wheels are turning, the tires keep slipping on the ice or snow. Deep treads on the soles of winter boots and on snow tires increase friction, making it safer to walk and drive in icy conditions.



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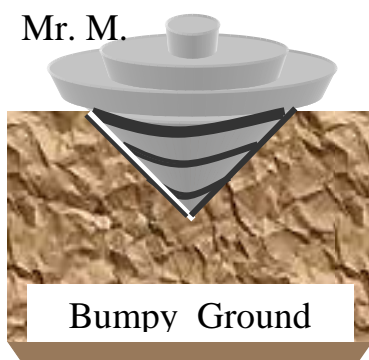
Increasing Friction

Figure 5: A Bike Tire

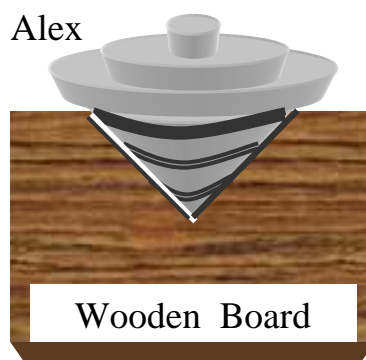
Figure 6: A Rubber Sole

Spin Your Top

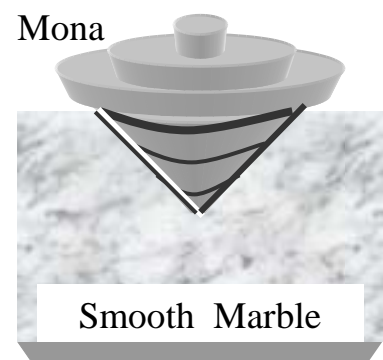
Figure 7: Spinning Similar Tops on Different Surfaces.



Mr. M.



Alex



Mona

Who is most likely to win? Why?

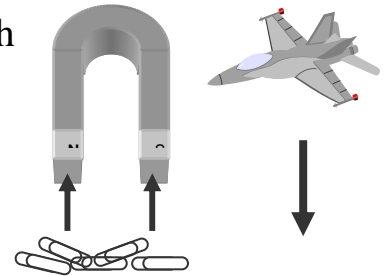
Direct and Indirect Forces

From the previous examples, we know that Ian and Prateek had to touch the box with their hands or other parts of their bodies like shoulders before they could push or pull it. You could also make objects move by pushing them with a stick or pulling them with a rope. If we don't make contact with an object, we can not move it.

Muscular force can only act directly in this way. It is a direct force.

Magnetism and gravity are different. Magnets don't have to touch paperclips to pull them and we all know that even when we fly high in the sky, gravity is still pulling us down.

Magnetism and gravity are indirect forces.



Energy

Moving objects have energy. When a penny hits another penny it gives it its energy and makes it move. Do the following experiment.

You'll need:

- 2 rulers
- 5 pennies
- 4 pieces of tape



Hit a row of 4 pennies with another penny from a short distance away and watch what happens. Record your observation below and draw it on the picture above.

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Stored Energy

Energy can be stored and used later. The food we eat has stored energy. If you pull an elastic band, your energy is stored in it until you let it go. You can bicycle to the top of a hill, but as soon as you get there, you have stored so much energy and do **not** need to spend any energy to go downhill. Springs can also store energy.